17. (New) A method according to claim 14, wherein:

the characterizing operation is performed with respect to the four characteristics of the steps; and

the determining operation is performed for each of the four characteristics.

REMARKS

Summary: By this Amendment and Response, the specification has been amended to correct typographical errors, and to properly refer to the FIGs., which correction does not add new matter. Copies of Figures 4B, 5B-1, 5A-2, and 32 have been submitted for the Examiner's review of corrections, and a Separate Letter to the Official Draftsperson responds to the drawing rejection. Claims 1, 6, 7, and 9-12 have been amended to clarify the claims and conform the text to antecedents. Claims 15-17 have been added to define certain aspects of Applicants' invention. Remarks are made for the patentability of the rejected claims.

Amendments To The Specification: Without adding new matter, the following amendments have been made. Pages 19, 22, 30, 31, 38, 40, 46, 51, 54, 57, 54, 57, 64, and 67 have been amended to correct obvious typographical errors. Page 21 has been amended to correct the Figures in which arrow 209H is shown. Page 28 has been amended to correct the Figures in which the structures 230 of the array 265 are shown. Page 31 has also been amended to correct the Figures in which structure of the motor 290 is shown, and to properly refer to the fluid 293 as being shown in FIG. 8, and to refer to an inlet for such fluid 293. Page 48 has been amended to delete a reference to an arrow not shown in Figure 1B. Page 83, has been

amended to correct a typographical error in paragraph 11 of Appendix B. The correction conforms to paragraph 14 of Appendix B, thus no new matter is added. Entry of these amendments is respectfully requested.

<u>Amendments To The Drawings:</u> Approval of amendments to FIGs. 4B, 5B-1, 5A-2, and 32 is respectfully requested. The amendments are circled in red. As to FIGs. 4B, 5B-1, and 5A-2, the reference numbers 265 denote the array of linear bearings described on page 28. As to FIG. 32, the reference number has been changed from 2001 to 2000 to conform to the specification at page 55 and to FIG. 31.

<u>Amendments To The Claims:</u> Claims 1, 6, 7, and 9-12 have been amended to clarify the claims and conform text to antecedents. The claim 1 amendment conforms "areas" at line 8 to the "areas" defined at line 2. The claim 6 amendment conforms the uses of "force control processor" to the original recitation at line 14, and at line 16 refers to "values" of relative movement to conform to the plural "increments" of movement defined at lines 12 and 13. The amendment to claim 7 corrects the grammar as to the output signals. The amendments to claims 9 and 10 provide appropriate "wherein" clauses and related grammatical changes. The claim 11 amendments correct punctuation (line 5), antecedents (line 7), other force control processor antecedents, and the time in the last clause. The claim 12 amendments correct typographical errors at lines 3 and 9. Entry of these amendments is respectfully requested.

<u>Response to Rejection of Apparatus Claims 1-5:</u> Claims 1-5 were rejected under 35 U.S.C. 102 (a) a being unpatentable over Hayashi et al ("Hayashi") based on what Hayashi "implicitly discloses". In the rejection, Hayashi was cited at column 7, lines 49-59 for the teaching of a <u>first</u> processor programmed to provide pressure data. Also, Hayashi at column

6, line 59 to column 7, line 47 was cited for the teaching of a <u>second</u> processor programmed to process data representing relative movement for providing area data.

<u>Discussion of Claim 1</u>

Reconsideration of this rejection is respectfully requested. Initially, it is noted that claim 1 defines first and second processors, and defines specific programming of each of the first and second processors with respect to the data processed by each separate processor. It is respectfully submitted that the claimed programming is part of the structure of the claimed apparatus by which processing capacity is not exceeded for critical operations of processing area data and pressure data (e.g., see the specification at page 74). Accordingly, the claimed programming should be given patentable weight.

It is respectfully submitted that there is no teaching in Hayashi, implicit or actual, of the <u>two</u> processors that are said to be "implicitly" (i.e., "impliedly") disclosed in Hayashi. In detail, the specifically disclosed (not implied) circuit 21 of Hayashi is only <u>one</u> processor. This is made clear at column 6, lines 47-48, which is a continuation of the description of Fig. 4 that starts at column 4, line 19. At lines 47-48 the control circuit 21 of Figure 4 is said to be "constructed by a computer, for example." Thus, the specific disclosure is of one computer.

Further, reference is made to the reference in the rejection to column 7, lines 49-59. While apparently intended to identify a disclosure of a <u>separate</u> processor, this portion of column 7 instead identifies a memory (see "store a relationship between..." at lines 48+). In more detail, at lines 51-54 it is clear that only the <u>one</u> computer (control circuit 21) calculates the contact area, and then that <u>one</u> computer calculates the load using pressure data. Moreover, that specific disclosure of the control circuit 21 does not state or imply that there is more than one computer. Thus, at columns 6 and 7 Hayashi

teaches only <u>one</u> computer. Further, there is no teaching in Hayashi, nor any reason in Hayashi to believe, that more than the one disclosed computer performs all of the operations described by Hayashi at the cited lines at columns 6 and 7.

It is further submitted that Hayashi's additional disclosures of the circuit 21 do not indicate that the one circuit 21 is anything more than one computer. For example, see column 8, lines 66+ (circuit 21 reducing the load, no specifics of computer); column 9, lines 27-37 (table in memory, no specific disclosure of computer at lines 32-33) ; and column 9, lines 45-48 (area calculated by circuit 21, no specific disclosure of computer at lines 45-47).

Further, Hayashi emphasizes providing a "definite" polishing pressure. In view of this, there is no reason in Hayashi to provide a separate processor, apart from the control circuit 21, to provide variable pressure data representing the pressure to be applied to the contact areas during polishing. Examples of where emphasis is placed on providing a "definite", i.e., constant, pressure include the following places in the Hayashi specification:

column 2, line 25 ("...polishing pressure can be constant...");

column 7, lines 44-47 ("...,polishing pressure P can be definite");

column 9, lines 9-12("...P can be definite");

column 9, line 36 (P is the definite ...pressure");

column 10, lines 61-67 (...P was caused to be definite);

column 11, lines 5 and lines 65-66; and

column 12, line 50.

Reference is also made to the Hayashi disclosure where there is discussion of non-definite polishing pressure. At column 10, lines 44-45, the polishing pressure P was raised "to a nonnegligible extent". The further discussion indicates that compensation for polishing cloth movement to produce constant polishing pressure is indispensable (column 10, lines 55-60). Thus, the provision in Hayashi of only one computer is consistent with a lack in Hayashi of a need to process variable polishing pressure, which Applicants identify as a source of overload of processing capacity, solved by Applicants' claimed first and second processors.

In review, it is respectfully submitted that:

> Claim 1, and thus dependent claims 2-5, define two separate processors, each having structure defined by each processor's own defined programming; and
>
> Hayashi fails to disclose or imply such claimed two separate processors, each having its own defined programming.

It is respectfully submitted that Hayashi does not anticipate claims 1-5.

Moreover, it is submitted that the differences between the one computer of the one control circuit 21 of Hayashi, and the claimed two processors with such programming, would not have been obvious under 35 USC Section 103. In detail, it is clear that Hayashi directly teaches one to use only one computer, which is a teaching <u>away from</u> using the two claimed processors with the claimed separately defined programming. It is submitted that when the reference teaches away from the claimed invention, the reference is not a proper basis for an obvious rejection.

In view of these remarks, it is submitted that claim 1, and dependent claims 2-5, are patentable over Hayashi, and allowance of these claims is respectfully requested.

Further Discussion of Dependent Claims 2-5

The rejection of Claims 2-5 further stated that:

> "...the apparatus of Fig. 4 performs all the functions ...set forth in claims 2-5 ...."the claims are directed to an apparatus which must be distinguished from the prior art in terms of structure rather than functions. Hence, the functional limitations which are narrative in form have not been given patentable weight, a functional recitation must be supported by recitation in the claims of sufficient structure to warrant the presence of the functional language".

Reconsideration of the statements concerning functional language in these claims is respectfully requested. Referring to claim 2, it is respectfully submitted that the second processor is further defined in terms of a characteristic which defines a structural limitation of a processor, namely "processing capacity". Moreover, the sufficiency of that capacity for real-time control is expressly defined in terms of values of variations of specific factors. The Examiner has not indicated how or why or what aspect of this limitation defining this characteristic is "functional", nor why any aspect of this characteristic is functional.

Referring to claims 3-5, it is respectfully submitted that the first and second processors are further defined in terms that define the programming of these processors. This programming defines structural limitations of the processor, namely what type of data is processed and what type of data is output. The Examiner has not indicated how or why or what aspect of these programming limitations are not structural, nor why any aspect of these limitations are functional.

It is further respectfully submitted that even if claims 2-5 were properly said to define only functional limitations, such limitations must be taken into consideration in a patentability determination. The Examiner stated that:

> "...the functional limitations which are narrative in form have not been given patentable weight, a functional recitation must be supported by recitation in the claim of sufficient structure to warrant the presence of the functional language. "

It is respectfully requested that in the determination of patentability, full weight be given to the statements recited in claims 2-5, whether or not such statements recite "functional" features of the defined processors of the apparatus. In support of this request, reference is made to <u>K-2 Corp. v. Salomon, S.A</u>., 52 USPQ2d 1001 (Fed. Cir. 1999). There, the phrase

> "for substantially preventing movement therebetween at least in a horizontal plane"

was interpreted by the CAFC. The CAFC characterized such phrase as "functional language". However, in stating that such "functional language is, of course, an additional limitation of the claim", the CAFC clearly recognized that patentable weight must be given to the language. Further, the CAFC referred to the <u>Wright Med. Tech., Inc. v. Osteonics Corp.</u> case, 43 USPQ2d 1837 (Fed. Cir. 1997) with approval and noted that in <u>Wright</u>, "functional language" was "analyzed as a claim limitation".

In view of the above remarks, it is respectfully submitted that in claims 2-5, each entire limitation recited in each claim is properly given weight in determining patentablity. When such weight is given to such limitations for patentability purposes, it is respectfully submitted that these claims further distinguish over Hayashi. For example, whereas the Examiner asserted that the apparatus of Fig. 4 performs all the functions set forth in claims 2-5, the above remarks make it clear that Fig. 4 does not show two computers, thus Hayashi does not define the processing capacity of a second processor (claim 2). Also, Hayashi does not define first and second processors, in which only the defined processing of claim 3 is

performed by the second processor. Another example is the programming defined in claim 5 to process the defined sequential data. Accordingly, in view of the features set forth in claims 2-5, there is further reason to allow claims 2-5, which action is respectfully requested.

Response to Rejection of Method Claims 12-14: Claims 12-14 were rejected under 35 U.S.C. 102 (a) as being unpatentable over Hayashi. In stating the rejection of the method claims, the Examiner also cited Hayashi at column 7, lines 49-59 for the teaching of a first processor programmed to provide pressure data, and cited Hayashi at column 6, line 59 to column 7, line 47 for the teaching of a second processor programmed to process data representing relative movement for providing area data.

Discussion of Claim 12

Reconsideration of this rejection is respectfully requested. Initially, it is noted that claim 12 defines a method of controlling pressure, in which there is an operation of providing a first processor and an operation of providing a second processor. Claim 12 defines the characteristics of the first and second processors in terms of the respective data that is processed. The processing of the specified data is an integral part of the definitions of the operations of the method by which the processing capacity of the processors is not exceeded, as described above.

It is respectfully submitted that there is no teaching in Hayashi of a method in which there is providing of two processors. In detail, by providing only the one circuit 21, Hayashi only provides one processor (column 6, lines 47-48, control circuit 21 is "constructed by a computer, for example.") As submitted above, the referenced Hayashi disclosure at column 7, lines 49-59 provides a memory (line 50), and no second processor is disclosed or implied. In detail, it is clear from lines 51-54 that only the one control circuit 21 calculates the contact area, and then that one computer calculates the

load using pressure data. Thus, providing of only one computer is taught by Hayashi, and that one computer performs all of the operations described by Hayashi at the cited lines at columns 6 and 7.

Further, as described above, given a goal of Hayashi to provide a constant pressure, in Hayashi there is not only no disclosure or implication of providing a second processor, there is no reason to have an operation of providing a separate processor, apart from the control circuit 21, to provide pressure data representing the pressure to be applied to the contact areas during polishing.

Because claim 12 defines operations of providing two separate processors, each having its own defined processing of data, and because Hayashi fails to disclose or imply the providing of such claimed two separate processors, each having its own defined data processing, it is submitted that Hayashi does not anticipate claim 12.

Moreover, it is submitted that the differences between a method of providing the one computer 21 of Hayashi and the claimed method of providing of two processors with the defined processing, would not have been obvious under 35 USC Section 103. In detail, it is clear that Hayashi directly teaches one to provide only one computer, which is a teaching away from providing the two claimed processors with the claimed processing. It is submitted that when the reference teaches away from the claimed invention, the reference is not a proper basis for an obvious rejection.

In view of these remarks, it is submitted that claim 12 is patentable over Hayashi, and allowance of claim 12 is respectfully requested.

Discussion of Claims 13-14

Claims 13-14 were rejected with the further comment that:

"...the apparatus of Fig. 4 performs all the functions and steps set forth in claims 2-5 and 12-14...the claims are directed to an apparatus which must be distinguished from the prior art in terms of structure rather than functions. Hence, the functional limitations which are narrative in form have not been given patentable weight, a functional recitation must be supported by recitation in the claims of sufficient structure to warrant the presence of the functional language".

Initially, in response to the rejection, reconsideration of the statements concerning functional language in these claims is respectfully requested. Referring to claim 13, it is respectfully submitted that the method is defined in terms of text that defines operations of the method, and not functions of apparatus. In detail, the first operation is

> characterizing steps of the chemical mechanical polishing operations according to the available processing capacity required for real-time processing of the steps at a rate sufficient for controlling the pressure to be applied to the contact areas of the wafer and of the polishing pad during the chemical mechanical polishing operations, the characterizing being with respect to at least one of the following characteristics of the steps:

The specific characteristics related to the characterizing are then defined. Further, the second operation is

> determining a value of the available processing capacity required for the real-time processing of the step data necessary to control the pressure to be applied to the contact areas of the wafer and of the polishing pad in the step of the chemical mechanical polishing operations.

Claim 14, based on claim 13, further defines the data processing referenced in the preamble of claim 13, and defines a "dedicated processor" with respect to which the "determining" operation is performed. This definition of the dedicated processor is in terms of the only types of data that are processed by the dedicated processor. It is respectfully submitted that the specification of a limited number of types of data that are processed is not a functional limitation, but is instead a specification of a characteristic of the dedicated processor. Accordingly, it is respectfully requested that weight be given to the operations defined in claims 13-14 in determining patentability. Similarly, new claims 15-17 define respective two, three and four characteristics with respect to which the characterizing and determining operations of claim 13 are performed, and thus also specify characteristics of the operations of the process and not functions of an apparatus.

As to the patentability of claims 13-17, it is respectfully submitted that Hayashi does not teach that the apparatus of Fig. 4 performs all (or any of) the operations set forth in claims 13-17. The operations Hayashi attributes to the circuit 21 in Fig. 4 are set forth on column 6, lines 19-58. There, the control circuit 21 is said to control the load, the rocking section 18, the motor, and the pump 20. Additionally, further on column 6 through column 9 reference is made to FIGs. 5A-5C, and 6A-6C, which describe conversion of displacement to area, and area and pressure to load (see columns 7, lines 17+; 35+; 55+, for example).

It is respectfully submitted that Hayashi does not teach any of the claimed operations of a method of determining a value of available processing capacity of a processor used for pressure control in CMP operations. In detail, it is submitted that no mention is made at columns 6-9 of any way of determining a value of available processing capacity of the circuit 21, for example, which is the one processor disclosed by Hayashi. Further, it is respectfully submitted that none of the four characteristics

defined in claim 13 is described by Hayashi in respect to characterizing CMP operations according to available processing capacity required for real-time processing of the CMP step. For example, as to the claimed "rate of relative movement" defined in claim 13, the Hayashi rocking speed described at column 12, line 49 is not related by Hayashi to available processing capacity required for such real-time processing by the circuit 21. As a further example, the problematic unevenness of the polishing described by Hayashi at column 11, lines 1-25 is not attributed to lack of available processing capacity of the circuit 21, but to variations in the polishing pressure (lines 19-20) and to polishing rate increase (lines 20-21). It is believed clear, then, that Hayashi does not teach all of the method operations recited in claims 13-17, such that these claims are patentable under 35 U.S.C. 102 (a) over Hayashi.

Moreover, it is submitted that the differences between the Hayashi description of its pressure control operations, and the claimed method of determining a value of available processing capacity for CMP operations, would not have been obvious under the standard in 35 U.S.C. 103. Hayashi notes problems in CMP polishing, but does not teach Applicants' claimed solutions that relate to determining a value of available processing capacity for CMP operations. For example, although Hayashi directly teaches a solution to the relative polishing rate of the central area (described on column 11, lines 1+), that solution is not the claimed solution of claims 13-17. Instead of determining a value of available processing capacity for CMP operations, as claimed, Hayashi uses the one disclosed processor of circuit 21 and (column 11, lines 26-39) cuts out the polishing cloth to provide an elliptic cloth (line 31). Further, in various descriptions of other solutions to CMP problems, Hayashi teaches use of different polishing cloths (column 15, lines 38 and 44). Finally, the summary at column 16, lines 8-20 does not even suggest that CMP operational problems may be solved by a method

of first determining a value of available processing capacity for CMP operations to be performed by a processor.

Rather, the specific teachings of Hayashi noted above are teachings <u>away from the claimed</u> determining a value of available processing capacity for CMP operations to be performed by a processor. It is submitted that when the reference teaches away from the claimed invention, the reference is not a proper basis for an obvious rejection. Still further, as to claim 14, although the Hayashi circuit 21 processes three types of data, since there is no operation in Hayashi corresponding to the claimed "determining" operation, and Hayashi does not teach performing such a "determining" operation with respect to three specific types of data.

In view of these remarks, allowance of claims 13-17 is believed to be in order, which action is respectfully requested.

<u>Response to Rejection of Claims 6-7, and 11:</u> Claims 6-7, and 11 were rejected under 35 U.S.C. 103 (a) as being unpatentable over Hayashi in view of Sandhu et al. '129 ("Sandhu"). In stating the rejection Hayashi was applied as discussed above, and it was acknowledged that Hayashi does not disclose a feedback circuit for providing output signals representing increments of the relative movement. Sandhu was cited as to Fig. 1, and column 6, line 54 to column 7, line 30, for disclosure a polish control system which adjusts in situ the platen velocity and/or the individual localized pressures applied to the wafer to change the polishing rates of the individual regions of the wafer. In respect to Sandhu the two-way arrows shown in Fig. 4 were said to represent feedback circuit (column 7, lines 25-30 were referenced) to provide in-situ adjustments of operational parameters such as platen speed, slurry composition/flow rate, and polishing pressures to achieve desired polishing uniformity and rates. The rationale for the combination of

Hayashi and Sandhu was said to be obviousness to modify the Hayashi polishing apparatus with a Sandhu-taught feedback circuit to provide the noted in-situ adjustments to achieve desired polishing uniformity and rates.

It is submitted that the combination of Hayashi and Sandhu is not proper because there is no proper teaching, motivation, or suggestion for the combination. Initially, it is submitted that the Court of Appeals for the Federal Circuit (CAFC) has consistently held, in determining whether a proposed combination of references is proper under the standard of 35 USC 103, that actual evidence of the suggestion, teaching or motivation to combine is required. For example, in In re Dembiczak, (CAFC case 98-1498, 4/28/99), the Court made it clear that the showing must be clear and particular, and that Examiner's statements unaccompanied by evidence or reasoning are inadequate to support the rejection. The Court made it clear, however, that particular factual findings regarding the suggestion, teaching, or motivation to combine are required, since they identify factual disputes, for example. Implicit in this requirement for factual findings, is that the facts found must be correct.

Here, it is respectfully submitted that there is no clear and particular evidence that one skilled in the art would be motivated to combine the references. In support of this position, it is respectfully submitted that the rejection does not recognize that neither reference teaches or suggests the use of two separate processors in pressure control for CMP.

The discussion of Hayashi in Office Action Paragraph 4 merely referred to the discussion of Hayashi in Office Action Paragraph 2. However, as set forth in detail in the above remarks responsive to such Paragraph 2, Paragraph 2 fails to acknowledge that Hayashi teaches use of only one control circuit 21, and that such circuit 21 has only one computer. As is clear from the above remarks, despite the Examiner's Paragraph 2 statement that Hayashi "implicitly" discloses first and second processors, the actual Hayashi disclosure

is that the control circuit 21 "is constructed by a computer, for example." It is not seen how Hayashi implies the teaching of two computers in view of this express teaching of one computer. Further, the fact that Hayashi repeatedly refers to the tasks performed by that one circuit 21 (computer) negates any implication that more than one computer is used.

Further, in Sandhu the controller 72 is used to interface with only one processor, 74. For example, the description at column 6, lines 58-62 makes it clear that all of the "parameters are input to processor 74", and that such one processor 74 determines a set of desired operational parameters. Thus, in Sandhu there is no appreciation of Applicants' teachings that for real-time operations it is necessary to separate the processing into one (central) processor for specifying relative movement and pressure data, and a separate processor for processing such movement and pressure data to provide contact area data and data defining the force to be applied for polishing. Sanhu Figs. 1 and 2 clearly show the one processor 74, and no description of that one processor 74 indicates that processing operations are separately performed by a second processor, such as the claimed force control processor. Moreover, the feedback noted by the Examiner (two-way arrows in Fig. 4) is supplied to an application controller 108, and not to a claimed force control processor. Further, the feedback shown in Fig. 1 is not to and from the processor 74, as claimed with respect to the force control processor, but is to and from the system controller 72. Importantly, in each case in which Sandhu uses feedback, the data fedback is applied to only one and the same processor 72, and not to separate central and force control processors.

In this situation, it is submitted that the In re Dembiczak case, supra, is pertinent. As noted, the Court made it clear that the showing of facts relating to combinations of references must be clear and particular, and that Examiner's statements unaccompanied by evidence or reasoning are inadequate to support the rejection.

Here, in review, neither reference teaches the important claimed concept of

use of the two separate processors, which facilitates provision of processing capacity for the critical machine control processing described in Applicants' specification at page 75, for example. Moreover, the rejection does not state why one skilled in the art would be motivated to combine the references in an attempt to provide the claimed two processors when neither reference teaches any disadvantages of the expressly taught respective single processors. Rather, the rejection merely states control and feedback aspects of Sandhu, and fails to provide any evidence as to motivation, teaching, or suggestion to combine the references. In the Dembiczak case, the Court made it clear that particular factual findings regarding the suggestion, teaching, or motivation to combine are required, since they identify factual disputes, for example. It is respectfully submitted that with the above characterizations of the Hayashi and Sandhu references in mind, the rejection lacks the evidence and reasoning required by the CAFC. Because the references are thus not properly combinable, the references are applicable only separately. As set forth above, neither individual reference teaches or suggests the defined two separate processors, such that allowance of claims 6-7, and 11 is believed to be in order.

As a further indication that the combination is not proper, in view of the single processor in each of the combined references, and the lack therein of any disclosure of disadvantages of the sole processor structure, it is submitted that it would be contrary to the specific teachings of these references to provide the claimed second (force control) processor. In detail, rather than providing a basis for combination, it is submitted that these teachings of the references are evidence against the claimed separate processors and their separate operations. In this regard, the CAFC found in Mitsubishi Electric Corp. v Ampex Corp. (8/30/99, CAFC case No. 97-1502) that a jury was properly instructed by an instruction that included

"you may not combine the features of prior art products where the prior art itself teaches against the combination".

For this additional reason, allowance of claims 6, 7 and 11 is respectfully requested.

As a still further reason that the combination is not proper, it is submitted that the claimed apparatus would only result from the impermissible hindsight use of Applicants' claims 6, 7 and 11 as a framework. For example, such framework as taught only by Applicants is the claimed separation of the processing by use of the central processor for certain processing, and the use of the force control processor <u>separate from the central processor</u> and responsive to pressure data and the defined output signals (relative movement of wafer and pad) to process two defined programs. Similarly, for example, only Applicants teach a force control processor separate from a central processor (claims 6 and 11), wherein the separate force control processor provides force data in two stages (claim 7) or converts position data to area data, and the area data with pressure data to force data. Neither reference appreciates the basis for the claimed separation of processing, which facilitates provision of processing capacity for Applicants' critical machine control processing.

In view of these additional reasons, allowance of claims 6, 7 and 11 is respectfully requested.

<u>Allowable Subject Matter:</u> Appreciation is expressed for the indication in Paragraph 5 that claims 8-10 would be allowable if written in independent form including all of the limitations of the base claim and any intervening claims. Applicants respectfully request leave to defer such rewriting until after the Examiner's review of the foregoing arguments. However, Applicants respectfully request approval of the amendments proposed to claims 9 and 10, which clarify these claims and do not expand the scope thereof. For example, claims 9 and 10 provide clarity by setting forth proper "wherein" clauses, and in claim 10 the last recitation of "force control processor" conforms to the antecedent.

In view of these remarks and amendments, it is believed that this Application is in condition for allowance, which action is respectfully requested.

Respectfully submitted,
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of	Atty. Docket No. LAM2P222A
SALDANA et al.	
Application No. 09/748,708	Examiner: G. B. M. Nguyen
Filed: December 22, 2000	Group Art Unit: 3723
For: POLISHING APPARATUS AND METHODS HAVING HIGH PROCESSING WORKLOAD FOR CONTROLLING POLISHING PRESSURE APPLIED BY POLISHING HEAD	Date: September 10, 2002

CERTIFICATE OF MAILING
I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, Washington, DC 20231 on September 10, 2002.

Signed: Kay Harlow
Kay Harlow

MARKED UP AMENDMENTS

Marked Up Amendments To The Specification

Amended paragraph starting at page 19, line19:

The processing of the data representing the forces, and of the polishing head positions with respect to the resulting contact areas, may be performed by a central [ly by a] processor, or separately by a force controller, according to operational criteria in a processor guideline. The processor guideline relates to the level of processing workload, and may be used to determine whether the central processor alone, or the processor in conjunction with the separate force controller, is suitable for processing the data representing the forces. The operational criteria may include the timing of variations of polishing pressures, e.g., pressure ramps, as one type of operational criteria that may result in a high processing workload. Other operational criteria relate to the rate at which the position of the polishing pad changes relative to the wafer, and/or to the pad conditioning puck.

Amended paragraph starting at page 21, line 11:

Another motion of the polishing head 202 and of the pad 209 on the head 202 for performing polishing of the wafer 206, for example, or for enabling the head 202 and the pad 209 to be conditioned, is movement horizontally (see arrow 209H). It may be understood from the arrows 209H in FIGs. 1A [,] <u>and</u> 1B [and 2A] , for example, that a force may be applied by the polishing pad 209 to certain structure. For example, a force FP-W may be applied by the pad 209 of the polishing head 202 to the wafer 206 (and thus to the wafer carrier 208) at different locations on the wafer 206. Such locations are indicated by the displacement DF-W measured from the axis 212 or 214. These motions may occur at any time "TN" during a CMP cycle. A time TN is referred to below to generally designate any instant of time during a CMP cycle, or during a step in a CMP cycle, whereas a particular time TN is designated by "T" followed by a number, e.g., an initial time T0, or a later time T1. These motions of the pad 209 and the wafer 206 may be referred to as relative movement between the pad 209 and the wafer 206, indicating that in other configurations of the system 200-1, for example, the wafer 206 may be moved (e.g., horizontally) and the pad 209 held against horizontal movement.

Amended paragraph starting at page 22, line 1:

The subaperture configuration of the system 200-1 introduces flexibility into the polishing operation by utilizing different or same removal rates on different regions of the exposed surface 204 of the wafer 206. Unlike the above-described conventional CMP systems wherein an entire polishing [head] pad <u>209</u> is in contact with the entire exposed surface of the wafer, in the subaperture CMP system 200-1, at any given time TN, the size, or value, of an area of a contact surface of the polishing pad 209 (of the preparation head 202) that is in contact with the exposed surface 204 of the wafer 206 may vary. In addition, in the subaperture CMP system 200-1, by preventing movement of the preparation head 202 toward

the wafer carrier 208, movement (see up portion of arrow 233, FIG. 2A) of the wafer carrier 208 toward the polishing head 202 results in applying a force FP-W only to selected regions 204R of the exposed surface 204 of the wafer 206, thereby removing excess materials from those selected regions 204R, exclusively, at a particular time TN. Further, as shown in FIG. 2A, one such selected region 204R of the exposed surface 204 of the wafer 206 is displaced horizontally from, or eccentric relative to, a central axis 212 of the wafer carrier 208. The central axis 212 is concentric with a central axis 214 of the wafer 206 carried by the carrier 208. As shown, the displacement of the force FP-W is indicated by DF-W, which is measured horizontally in FIGs. 1A, 1B and 2A. It may be understood from the arrow 209H that the polishing head 202 may move horizontally and contact different ones of the selected regions 204R of the exposed surface 204.

Amended paragraph starting at page 28, line 12:

FIGs. 4B, 5B-1 and 5A-2 show the multiple linear bearing structures 230 (shown in FIG. 2A) as including an array 265 of the linear bearings 253. The array 265 is configured to divide the operation of the multiple linear bearing structures 230 into parts having a short length in the direction of the axes 212 and 214 and small diameters relative to the diameters (e.g., eight inches) of the wafers 206 and the pucks 218. Moreover, such division locates the linear bearings 253 of the structures 230 at uniformly spaced intervals around a circular path 266 (FIG. 5B-3). In this manner, as the wafer carrier 208 or the pad conditioning head 220 rotate, there is a rapid succession of individual linear bearings 253, for example, located under the eccentric force FP-W that is to be sensed in the operation of the CMP system 200-1.

<u>Amended paragraph starting at page 30, line 13:</u>

As described above, FIG. 1B shows the initial orientation of the wafer carrier [head] 208. The <u>carrier</u> [head] 208 includes the retainer ring base 280 and the retainer ring 282. The retainer ring base 280 surrounds and is spaced from the vacuum chuck 262. The retainer ring 282 is designed to be engaged by the polishing pad 209 during the wafer polishing operations, and the polishing pad 209 imparts a force FP-R on the retainer ring 282. The force FP-R is eccentric with respect to the axis 212 of the wafer carrier 208.

<u>Amended paragraph starting at page 31, line 5:</u>

Thus the structure 232 is resistant to all except a vertical component <u>(not shown, but identified as</u> FP-RV<u>)</u> of this eccentric force FP-R applied to the retainer ring 282. In detail, the set 270 of three [bearings] linear bearings <u>272</u> [273] assures that structure of the retainer ring 282 is not allowed to move in an undesired manner in response to such an eccentric force FP-R. Thus, the linear bearings 272 assure that such eccentric force FP-R does not move such retainer ring 282, except as follows. The retainer ring 282 is permitted to move vertically, parallel to the initial third orientation of the central axis 212 of the respective wafer carrier 208, which are coaxial. As a result, the eccentric load FP-R (shown in FIG. <u>2A</u> [2B] acting <u>downwardly</u> [on the retainer ring 282]), minus the force FF relating to the structure 232, is transferred to the retainer ring bearing plate 279 as the permitted vertical force component FP-RV. Referring to <u>FIG.</u> [FIGs.] 2A [and 6B], for example, it may be understood that the motion of the retainer ring 282 <u>(shown in FIG. 1E-3 for example)</u> that is limited by the structure 232 is independent of the motion of the wafer carrier 208 that is limited by the structure 230.

Amended paragraph starting at page 31, line 18:

A force actuator, or linear motor, 290 is mounted between the chuck bearing and load cell plate 260 and the retainer ring bearing plate 279. The linear motor 290 may preferably be provided in the form of a sealed cavity, or more preferably in the form of a pneumatic motor, or an electromagnetic unit, or an electromechanical unit. A most preferred linear motor 290 includes structure shown in FIGs. 7, 12A, 13A, and 14A, [is shown in FIGs. 5A-1, 5B-1, 7, 12A, 13A and 14A] including a pneumatic bladder 292 supplied with pneumatic fluid [(see arrow] 293 (FIG. 8) [)] through an inlet (not shown) [294]. As shown in FIGs. 5B-1 and 13A the chuck bearing and load cell plate 260 is provided with an annular groove 296 for receiving the bladder 292. The linear motor 290 is selectively actuated by supplying the fluid 293 to the bladder 292 at different amounts of pressure (PB) according to the amount of a desired stroke of the bladder 292. For example, referring to FIGs. 12A and 12B, a maximum stroke of the bladder 292 may be 0.10 inches measured vertically. Such maximum stroke compares to a vertical dimension (or thickness) of the wafer206, which may be 0.02 inches. For purposes of description, the plate 260 may be said to be fixed in the vertical direction, such that when the fluid 293 is admitted into the bladder 292 the bladder will urge the plate 279 upwardly by a distance corresponding to the particular stroke of the bladder 292 resulting from the pressure of the fluid 293. The bladder 292 will thus move the retainer ring bearing plate 279, and thus move the retainer ring base 280 and the retainer ring 282, up (in this example) relative to the wafer 206 positioned on the vacuum chuck 262, and relative to the pad 209 positioned relative to the retainer ring 282 as shown in FIG. 1C-2, for example.

Amended paragraph starting at page 38, line 23:

FIGs. 3A and 9 show the bottom 366 of the upper section 342. Four ports in the upper section 342 are provided for the facilities 338. A first port 368 mates with a similar

port (not shown) of the lower section 344 to supply the DI water and vacuum (see arrow 348). The port 368 receives a standard conical seal that extends from the similar port of [0] the lower section 344. The DI water 348 flows, and the vacuum 348 is applied, through the port 368, past an O-ring 370 shown in FIG. 5A-1 to a nozzle 372 shown in FIG. 5B-1 threaded into a threaded port 374 of the plate 260.

Amended paragraph starting at page 40, line 13:

A porous layer 297 is mounted on the upper surface 422. The layer 297 is fabricated from porous ceramic material having relatively large pores 297P (FIG. 7). The relatively large pores 297P provide passageways through which the DI water 348 flows or the vacuum 348 is applied from the manifold 420. The large pores 297P are located uniformly across the entire area of the vacuum chuck 262 and thus apply the vacuum from the manifold 420 across the entire area of the chuck 262. Similarly, the large pores 297P supply the DI water 348 all across the area of the chuck 262. Further, the large size pores 297P [279P] are not so large that the application of the vacuum 348 will deform the wafer 206 as in the prior use of relatively few (e.g., six) vacuum holes in direct contact with the wafers 206. For all of these purposes, the pores 297P may preferably have a large pore size, and more preferably a pore size in the range of from about twenty to about fifty microns, and most preferably about thirty to about forty microns, which is significantly greater than typical ceramics having pore sizes in the submicron range to one micron.

Amended paragraph starting at page 46, line 3:

The puck is purged to remove polishing debris and other material. The puck 218 is shown in FIGs. 16A, 16B, and 19B as including two disk-like layers 902A and 902B that are adhered to each other. A first layer 902A is fabricated from carbon steel that is provided with perforations 903. The perforations 903 may be apertures having a size of about 0.150

inches, for example. The perforations 903 are uniformly spread over the entire layer 902A [209A]. The perforated carbon steel layer 902A is nickel plated. The perforated and nickel plated layer 902A [209A] is then coated with diamond material. The layer 902A [209A] is in the form of a disk having a diameter of about 9.5 inches, which conforms to the diameter of the outer portion of the retainer ring 282 and to the diameter of the second layer 902B [209B]. The second layer 902B [209B] is a magnetic disk having an adhesive backing. The layer 902B [209B] is provided with smaller perforations or openings 904. For example, the openings 904 may have a size in the range of from about 0.010 inches to about 0.015 inches. The puck 218 is mounted on the pad conditioning head 220 with the layer 902B touching the head 220 so that the diamond coated surface faces the pad 209.

Amended paragraph starting at page 48, line 6:

Referring to FIG. 23, the present invention provides a method for controlling relative movement between the wafer 206 and the CMP polishing pad 209. The method may include an operation 1000 of mounting the wafer 206 on the chuck 262. It may be recalled that the wafer 206 has an axis 214, which may be referred to as an axis of symmetry. This mounted position is described above as the initial position of the wafer axis 214. The method moves to operation 1002 by offsetting the axis 210 of the polishing pad 209 and the axis of symmetry 214 of the mounted wafer 206, which is shown in FIG. 1B. The axis 210 is the axis on which the pad rotates. The method then moves to an operation 1004 by urging the pad 209 and the offset wafer 206 toward each other parallel to the axis of symmetry 214 [, as shown by the arrow 209V in FIG. 1B] . With the rotary tool changer urging the wafer carrier 208 upwardly and holding the chuck 262 at a fixed position in the direction of the axis 212 of the wafer carrier 208, the urging operation 1004 causes the pad 209 to impose a polishing force, such as the force FP-W, on the contact area APW of the mounted wafer 206 eccentrically with respect to

the axis of symmetry 214. In response to the polishing force FP-W, the wafer 206 has the above-described tendency to tilt such that the axis of symmetry 214 tends to move out of parallel with the axis 210, which is the axis of rotation of the pad 209. During the urging, the method moves to an operation 1006 by resisting the tendency of the mounted offset wafer 206 to tilt while allowing the wafer 206 to move parallel to the direction of the axis of rotation 210, and along the initial position of the wafer axis 214. The movement along the initial position of the wafer axis 214 is in response to the force FP-WV in FIG. 2A, for example, and reflects the operation of the linear bearings 232 in response to the eccentric force FP-W. The method may also move to an operation 1008, which during the urging operation and the resisting operation, is performed by measuring the movement of the wafer 206 parallel to the direction of the axis of rotation 210 to indicate a value of the polishing force, i.e., the force FP-W. The operations shown in FIG. 23 are then done.

<u>Amended paragraph starting at page 51, line 6:</u>

Referring to FIG. 26, another aspect of the present invention provides a method for controlling relative movement between the wafer 206 and a chemical machining pad 209. The method may include an operation 1040 of mounting the wafer 206 on the <u>chuck</u> 262 [chuck], the wafer 206 having the axis of symmetry 214 perpendicular to a polishing surface of the pad 209 and coaxial with the carrier axis 212, and parallel to the axis of rotation 211 of the pad 209. The method moves to operation 1042 by offsetting the axis of rotation 211 of the pad 209 from the axis of symmetry 214 of the mounted wafer 206. The method moves to operation 1044 by resisting movement of the polishing surface of the pad 209 toward the wafer 206. The chuck support plate 260 is provided for this purpose. The chuck 262 is movable relative to the chuck support plate 260. The method moves to operation 1046 by providing the retainer ring unit (e.g., ring 282 and base 280) around the chuck 262 for

movement to retain the wafer 206 on the chuck 262 (e.g., assist in placing the wafer 206 on the chuck 262, FIG. 12B). The retainer ring 282 may also expose the wafer 206 to the surface of the pad 209 for polishing (FIG. 14A). The method moves to operation 1048 by providing the chuck 262, the chuck support plate 260, and the retainer ring units (280 and 282) with a plurality of pairs of linear bearing assemblies 230 and 232, each of the assemblies having a housing 254 or 274 provided with a bearing axis perpendicular to the polishing surface of the pad 209. Each of the assemblies has the linear shaft 258 or 278 received in a respective one of the housings 254 or 274. The first set 252 of the assemblies is between the chuck 262 and the retainer ring units (280 and 282), and the second set 270 of the assemblies is between the chuck 262 and the chuck support plate 260. The method moves to operation 1050 by holding the chuck support plate 260 at a fixed position along the axis 212 to resist the movement of the polishing surface of the pad 209 toward the wafer 206. Alternatively, the plate 260 may be urged toward the pad 209. On either case, the pad 209 imposes the polishing force FP-W on the mounted wafer 206 and the force FP-R on the retainer ring 282, each force being eccentric with respect to the axis of symmetry 214. In response to the polishing force FP-W the wafer 206 and the chuck 262 have the tendency to tilt such that the axis of symmetry 214 tends to move out of parallel with the axis of rotation 210. Referring to FIG. 27, during the holding operation 1050 an operation 1052 is performed by which the first set 252 of the assemblies is effective to limit the movement of the retainer ring 282 to movement parallel to the axis of symmetry 214. During the holding of the chuck support plate 260, for example, operation 1054 is performed by which the second set 270 of the assemblies is effective to limit movement of the chuck 262 relative to the chuck support plate 260 to movement parallel to the axis of symmetry 214.

Amended paragraph starting at page 54, line 8:

Referring to FIG. 31, the present invention also provides a method for controlling relative movement between the chemical machining pad 209 and the pad conditioning puck 218. The method may include an operation 1090 of mounting the puck 218 on the chuck 322, the puck 218 having the initial axis of symmetry 224 and a puck surface parallel to the polishing surface of the pad 209. The pad 209 has the axis of rotation 211. The method moves to operation 1092 by offsetting the axis of rotation 211 of the pad 209 from the axis of symmetry 224 of the mounted puck 218. The method moves to operation 1094 by providing the chuck support plate 308 for resisting movement of the polishing surface of the pad 209 toward the puck 218, the chuck 322 being movable relative to the chuck support plate 308. The method moves to operation 1096 by providing the chuck 322 and the chuck support plate 308 with a plurality of pairs of linear bearing assemblies 304. Each of the assemblies 304 has a housing 316 provided with a bearing axis perpendicular to the polishing surface of the pad 209. Each of the assemblies 304 has a linear shaft 320 received in a respective one of the housings 316. The assemblies 304 are between the chuck 322 and the chuck support plate 308. The method moves to operation 1098 by holding the chuck support plate 308 at a fixed position to resist the movement of the polishing surface of the pad 209 toward the puck 218. The pad 209 imposes the conditioning force FP-W on the area APC of the mounted puck 218 eccentrically with respect to the axis of symmetry 224. In response to the conditioning force FP-C, the chuck 322 and the puck 209 on the chuck 322 have a tendency to tilt such that the axis of symmetry 224 tends to move out of parallel with the axis of rotation 211. During the holding of the chuck support plate 308 at the fixed position the method moves to an operation 1098 in which the assemblies 304 are effective to cause the mounted puck 218 to resist movement of the polishing surface of the pad 209 and the puck 218 towards each other. Referring to FIG. <u>32</u> [31], the method moves to an operation 2000 to limit movement of the chuck 322 relative to the chuck support plate 308 to movement parallel to the initial position

of the axis of symmetry 224. In this manner the puck surface remains parallel to the polishing surface. The method may move to operation 2002 by sensing the limited movement of the chuck 322 relative to the chuck support plate 308 to indicate an accurate value of the conditioning force FP-CV.

<u>Amended paragraph starting at page 57, line 8:</u>

Referring to FIG. 36, another aspect of the method of the present invention relates to a method of conditioning a polishing pad. The method starts with an operation 2070 of mounting the puck 218 on the <u>chuck</u> 322 [chuck] with the puck axis <u>224 of</u> symmetry perpendicular to polishing surface of the pad 218 and the puck conditioning surface parallel to the polishing surface. The method moves to an operation 2072 of offsetting the axis of rotation 210 from the axis of symmetry 224 of the mounted puck 218 with the axes 210 and 224 parallel to define an initial orientation of the puck 218. The method moves to an operation 2074 of moving the polishing surface of the pad 218 and the conditioning surface of the puck 218 toward each other. The method moves to an operation 2076 of providing the array 265 of linear bearing assemblies 310 adjacent to mounted puck 218. Referring to FIG. 37, the method moves to an operation 2078 of using the assemblies 310 during the move operation 2074 to substantially limit movement from the initial orientation and permit only movement of the mounted puck 218 with the conditioning surface parallel to the polishing surface. The method moves to an operation 2080 of sensing the limited movement to indicate an accurate value of the polishing force FP-C applied on the conditioning surface.

<u>Amended paragraph starting at page 64, line 1:</u>

Concerning criteria 1 of configuration criteria 2122, an end detection situation related to decreasing polishing pressure is described with reference to FIG. 42A, which shows the wafer 206 overlapped by the polishing pad 209. The polishing pressure may be decreased

with time in order to decrease the polishing rate of the wafer 206 as the desired wafer thickness is approached. Time TN may be an initial time T0 as shown in FIG. 1C-1 with the edge of the pad 209 tangent to the Y axis center line of the wafer 206. The time T0 [TO] identifies the point at which the edge of the pad 209 engages the contact area APW of the wafer 206, with the edge adjacent to the center line of the wafer (see h1). The corresponding contact area APW of the pad 209 is shown tending to remove the wafer 206 at a higher rate from parts of the wafer 206 that are nearest to the center line of the wafer (at h1) as compared to lower removal rates nearer to or at the edge 2126 of the wafer 26 corresponding to time Td, for example. The variation in removal rates is shown by a series of dashed lines 2128. It may be understood that in a period of time from time T0 [TO] to time Tc the pad 209 has removed a thickness of TH1 from the wafer 206 adjacent to the center line h1, whereas in the same time period the pad 209 has removed a thickness substantially less than TH1 from the wafer 206 adjacent to the edge 2126 of the wafer 206.

Amended paragraph starting at page 67, line 3:

Assuming the system 2100 has been selected according to these configuration criteria 2122, system 2100 may be used as follows. The recipe editor 2116 has defined all criteria related to the CMP process in the form of the edited recipe 2114. The edited recipe 2114 is output to a bus 2144 and stored in a hard drive 2146, for example. The edited recipe 2114 may include data corresponding to the list of process variables set forth in Appendix A below. The processor 2110 reads the edited recipe 2114 from the hard drive 2146 and processes data necessary to set up and operate the above-described hardware of the CMP system 200-1. This includes axis motion data, including pad motion data 2150, pressure profile data 2152 (for each area AP), process sequence data, and other data necessary to operate the carrier 208, the polishing [pad] head 202 and the retainer ring motor 290, for

example. The processor 2110 defines the edited recipe 2114 in terms of a table of sequences in which steps are taken to perform the CMP operations.

Amended page 83, Appendix B, paragraph numbered 11:

11. **EC2** – returns or sets right [left] limit for the encoder.

Marked Up Claims

1. (Once Amended) Apparatus for processing data for controlling a pressure to be applied to contact areas of a wafer and a polishing pad during a step in chemical mechanical polishing operations, the apparatus comprising:

a first processor programmed to provide pressure data representing the pressure to be applied to the contact areas during a polishing step; and

a second processor programmed to process data representing relative movement between the wafer and the pad in overlapped contacting positions for providing area data representing a value of the contact areas [area] between the wafer and the pad in the overlapped positions;

the second processor being further programmed to process the area data and the pressure data for providing force data representing the force to be applied to the contact areas during the polishing step of the sequence.

6. (Once Amended) Apparatus for controlling a first pressure to be applied to first contact areas of a wafer and a polishing pad in chemical mechanical polishing operations, the pressure being applied according to force data specifying the value of

forces to be applied to first contact areas, the apparatus comprising:

a drive system configured to cause relative movement between the wafer and the pad into overlapped positions;

a central processor for processing data to specify the chemical mechanical polishing operations, the data including a command to the drive system to cause the relative movement, the data further representing the pressure to be applied to the first contact areas of the wafer and the polishing pad;

a feedback circuit for providing output signals representing increments of the relative movement; and

a force control processor separate from the central processor, the <u>force control processor</u> [controller] being responsive to both the pressure data and [to] the output signals representing [the] actual <u>values of the</u> relative movement, the force <u>control processor</u> [controller] successively processing a contact area program and a force program to provide force data representing the force to be applied to one of the first contact areas of the wafer and the pad.

7. (Once Amended) Apparatus as recited in claim 6, wherein the force control processor provides the force data in two stages, a first stage being in response to <u>one of</u> the output <u>signals</u> [signal] to provide area data representing a value of the contact areas, a second of the stages being in response to the pressure data and to the [contact] area data to provide the force data.

9. (Once Amended) Apparatus as recited in claim 6, wherein [in which] a retainer ring is provided for orienting the wafer, wherein the apparatus further controls [controlling] a second pressure to be applied to second contact areas of the ring and the pad, wherein the relative movement causes [causing] relative movement of the ring and the pad, and wherein [the apparatus further comprising]:

the central processor further processes [processing] second pressure data representing a value of the second pressure; and

the force control processor is [being] further responsive to the second pressure data and to the output signals representing the relative movement of the wafer and the pad, the force control processor [controller] further successively processes [processing] the contact area program and the force program to provide second force data representing the force to be applied to the second contact areas of the ring and the pad.

10. (Once Amended) Apparatus as recited in claim 6, wherein [in which] a pad conditioning puck is provided for conditioning the pad, wherein the apparatus further controls [controlling] a second pressure to be applied to second contact areas of the puck and the pad, wherein the relative movement causes [causing] relative movement of the puck and the pad, and wherein [the apparatus further comprising]:

the central processor further processes [processing] second pressure data representing a value of the second pressure; and

the force control processor is [being] further responsive to the second pressure data and to the output signals representing the relative movement of the wafer and the pad, the force control processor [controller] further successively processes [processing]

the contact area program and the force program to provide second force data representing the force to be applied to the second contact areas of the puck and the pad.

11. (Once Amended) Apparatus for maintaining a constant pressure to be applied to respective contact areas of a wafer and of a polishing pad in chemical mechanical polishing operations, the apparatus comprising:

a drive for causing relative movement between the wafer and the pad into a plurality of different overlapped positions [,] ;

a force application system for urging the wafer and the pad against each other so that in each of the different <u>overlapped</u> [overlap] positions the respective contact areas are in contact and have different values, the system being capable of providing different forces for the urging;

a feedback circuit for providing first and second output signals representing respective first and second increments of the relative movement, the first and second increments being at spaced first and second times;

a central processor programmed for computing first position data in response to the first output signal, the first position data representing the actual relative movement at the first time, the central processor being further programmed for computing second position data in response to the second output signal, the second position data representing the actual relative movement at the second time, the central processor being further programmed for computing pressure data representing the constant pressure to be maintained; and

a force <u>control processor</u> [controller] separate from the central processor, the force <u>control processor</u> [controller] being programmed for converting the first position data to first area data representing the value of <u>a</u> [the] first <u>of the</u> contact <u>areas</u> [area] at the first time, the force <u>control processor</u> [controller] being further programmed to process the first area data and the pressure data to output first force data representing a first force to be applied to the first contact area at the first time;

the force application system being responsive to the first force data for urging the wafer and the pad against each other with the first force to provide the constant pressure on the first contact area at the first time;

the force <u>control processor</u> [controller] being further programmed for converting the second position data to second area data representing the value of <u>a</u> [the] second <u>of the</u> contact <u>areas</u> [area] at the second time, the force <u>control processor</u> [controller] being further programmed to process the second area data and the pressure data to output second force data representing a second force to be applied to the second contact area at the second time;

the force application system being responsive to the second force data for urging the wafer and the pad against each other with the second force to provide the constant pressure on the second contact area at the <u>second</u> [first] time.

12. (Once Amended) A method of controlling a pressure to be applied to contact areas of a wafer and of a polishing pad in chemical mechanical polishing operations, the <u>method</u> [apparatus] comprising the operations of:

providing a first processor to input pressure data representing the pressure to be applied to the contact areas during a polishing step;

providing a dedicated processor other than the first processor to only process three types of data, one type of data being data representing relative movement between the wafer and the pad in overlapped contacting positions, the pressure data being the second type of data [pressure data];

by use of the dedicated processor, computing area data representing a value of the contact area between the wafer and the pad in the overlapped positions, the area data being the third type of data; and

by use of the dedicated processor, processing the area data and the pressure data to compute force data representing the force to be applied to the contact areas during the polishing step of the sequence.

FIG. 4A

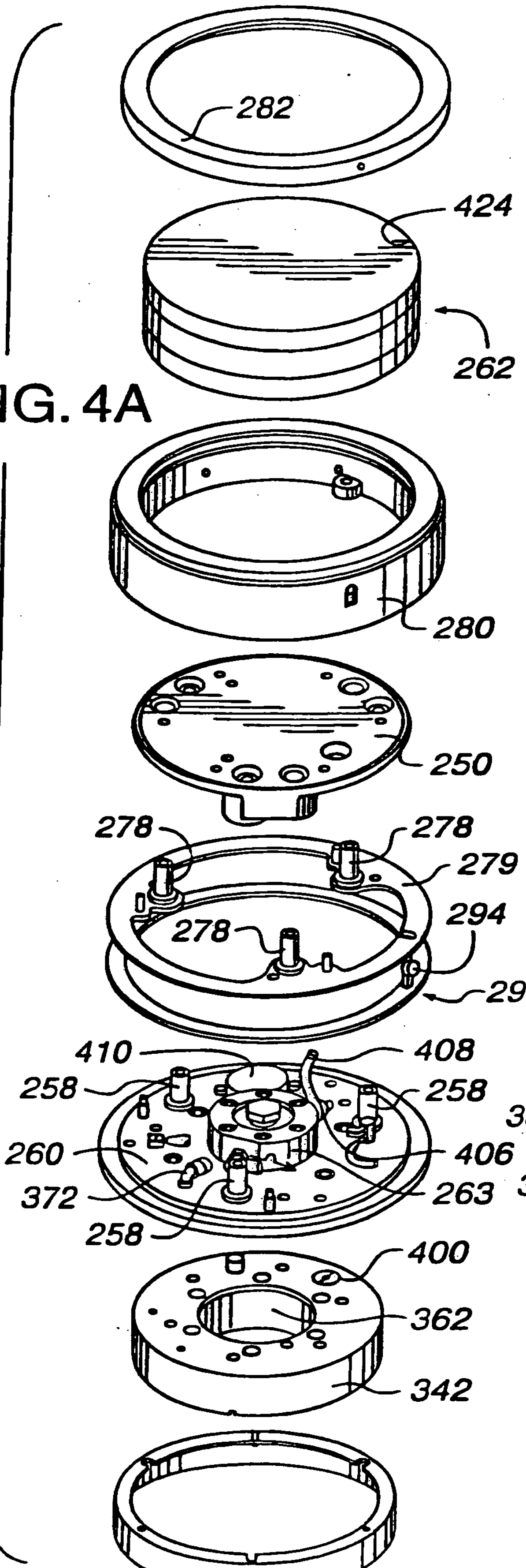
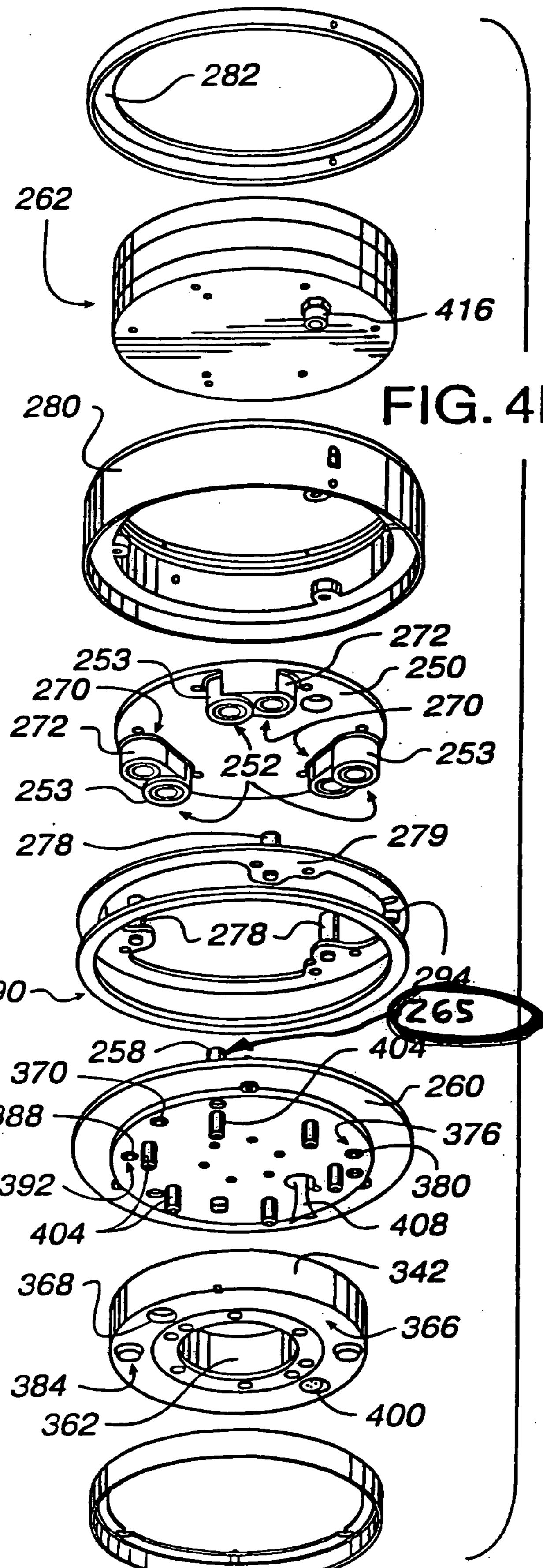

282
424
262
280
250
278
278
279
278
294
290
410
408
258
258
260
406
372
263
258
400
362
342

FIG. 4B


282
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272
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270
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342
366
384
400
362

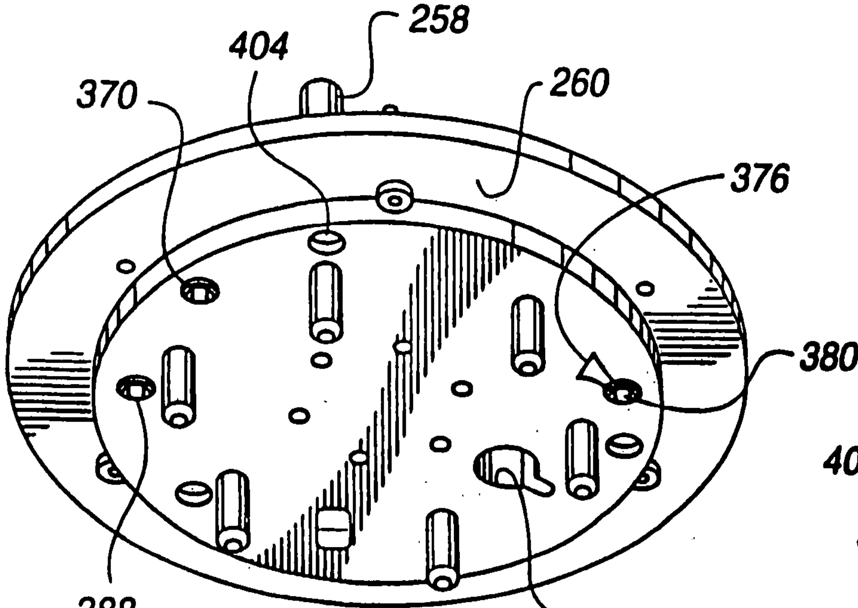

FIG. 5A-1

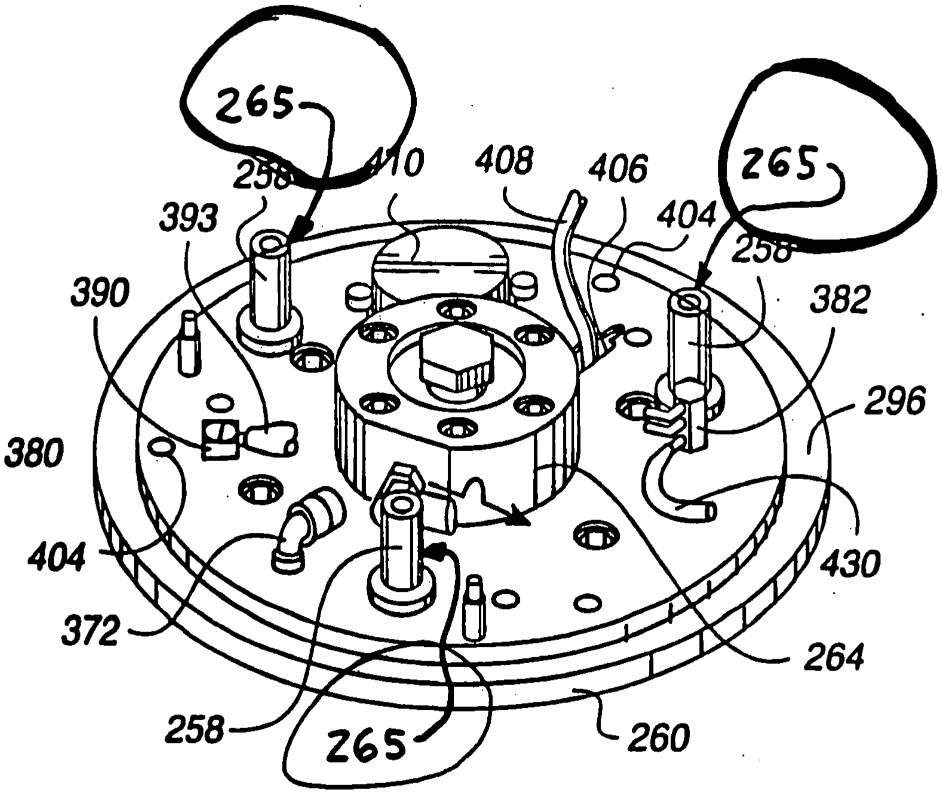

FIG. 5B-1

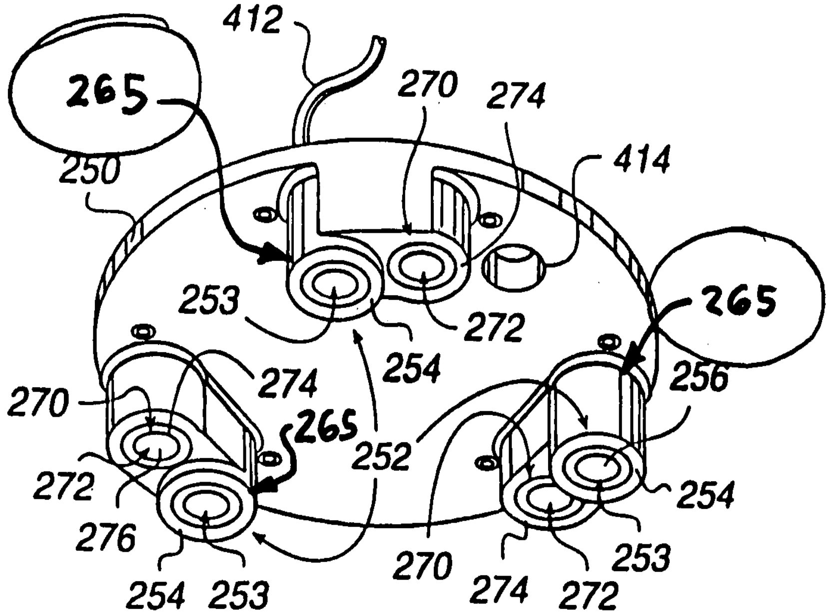

FIG. 5A-2

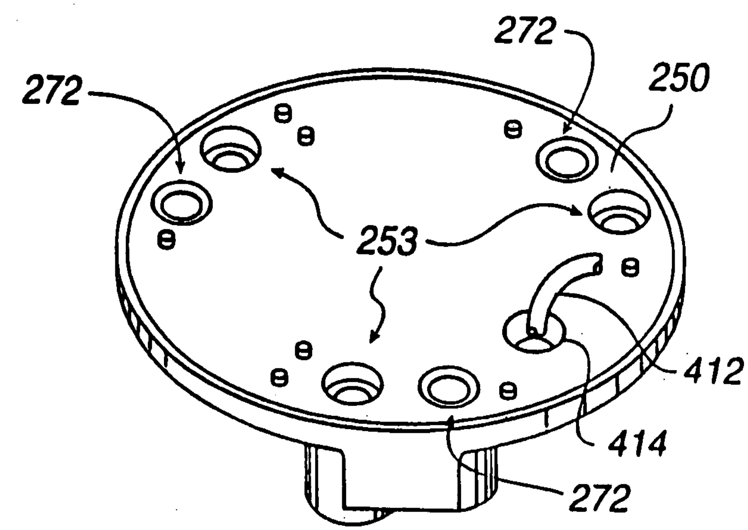

FIG. 5B-2

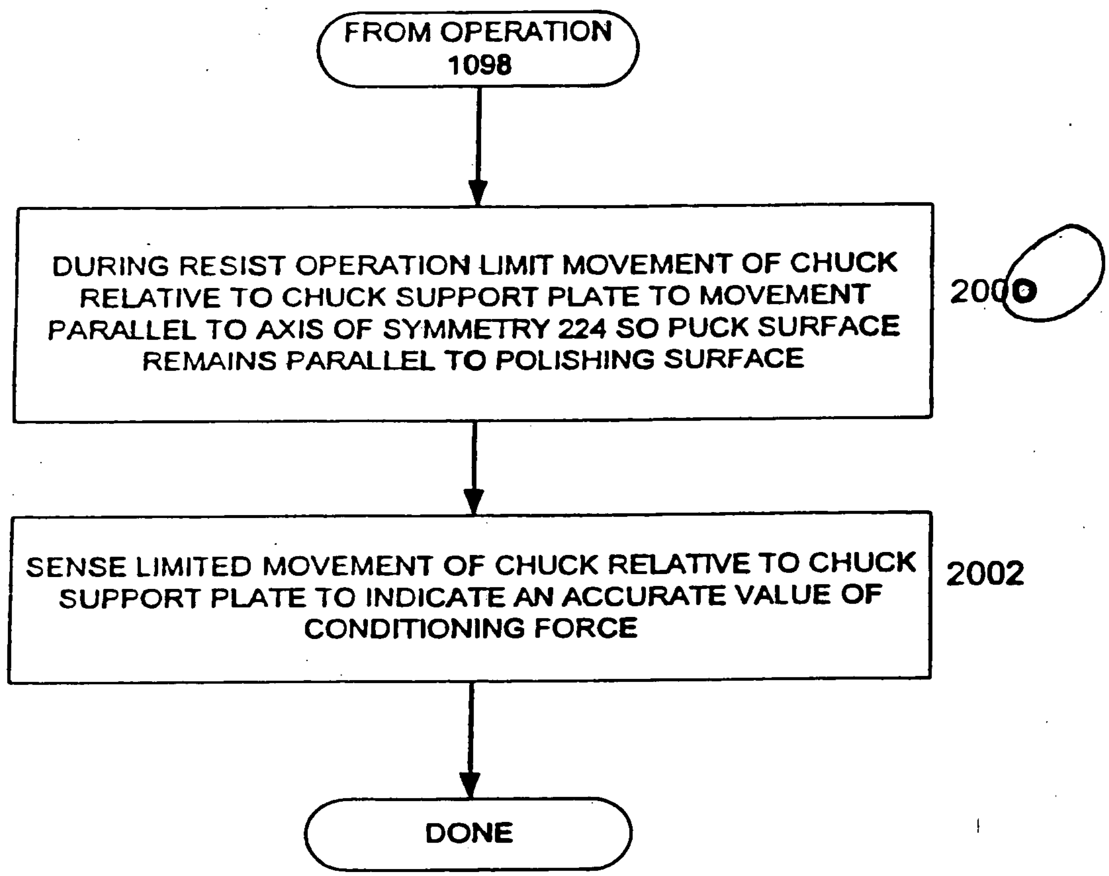
FROM OPERATION 1098
DURING RESIST OPERATION LIMIT MOVEMENT OF CHUCK RELATIVE TO CHUCK SUPPORT PLATE TO MOVEMENT PARALLEL TO AXIS OF SYMMETRY 224 SO PUCK SURFACE REMAINS PARALLEL TO POLISHING SURFACE
2000
SENSE LIMITED MOVEMENT OF CHUCK RELATIVE TO CHUCK SUPPORT PLATE TO INDICATE AN ACCURATE VALUE OF CONDITIONING FORCE
2002
DONE

FIGURE 32